Applicant respectfully requests that the above amendment be entered into record and that the application be so amended.

Respectfully Submitted

Shalom W.

Shalom Wertsberger

Reg. Num 43,359
30 Fern Lane
South Portland, ME 04106
Phone: (207) 799-9733
Fax: (207) 228-3694

Agent for Applicant

FIG. 2 illustrates the location-dependent information available from a typical cellular network utilizing sectored cells.

FIG. 3 illustrates a system in accordance with one embodiment of the present invention.

FIG. 4 illustrates a first embodiment of the transition network formed in a method of the invention.

FIG. 5 illustrates the initial position of each node in the network of FIG. 4.

FIG. 6a-6d illustrate the adjusting of node positions in the first embodiment of the transition network.

FIG. 7 illustrates a second embodiment of the transition network of the invention.

FIG. 8a- 8c illustrate the adjusting of node positions in the second embodiment of the transition network.

FIG. 9a- 9c illustrate the links relating to the nodes whose positions are adjusted in FIG. 8a- 8c.

FIG. 10 illustrates the general process according to one aspect of the invention.

FIG. 11 is a flow diagram illustrating an example of optimization of the transition network.

Detailed Description of the Invention

[25] As mentioned above, the method of the invention applies to various kinds of location-dependent information. According to the cellular system in question, the location-dependent information provided by the network can be signal strength or signal delay, for example. The determination of the location in current cellular networks is widely based on the Timing Advance value, because the Timing Advance value is directly available from the network. Therefore, Timing Advance is in this context used as an example of the location-dependent signal information available from the mobile network for location determination.

[26] As is known, Timing Advance indicates how far from the base station the mobile most probably is located. FIG. 1 illustrates the location dependent information provided by a network with omni-directional base station antennas, whereas FIG. 2 illustrates the same in connection with sectored cell sites. The network typically provides the Timing Advance information as the minimum and maximum distance from the antenna (R_{min} and R_{max}), in which case with a certain probability the mobile terminal is located between these limits, i.e. the hatched

nodes, each belonging to a different path. Thus, in this case each of the nodes marked by a triangle in FIG. 4 is not stored as a single node, but rather as a node group in which each node belongs to a different path. Using the above example, FIG. 7 illustrates the logical content of the accuracy database in the second embodiment. The database includes separate paths P1...P1000, each comprising several nodes. If two nodes, such as nodes N11 and N21, represent the same parameter set, links (pointers) are created from each of said nodes to the neighboring nodes of all the other nodes representing the same parameter set. Thus, each node can include two types of links, those linking the node to the neighboring nodes in the same path and those linking the node with the neighboring nodes of the other nodes representing the same parameter set as the node itself. Although the database now includes redundancy, this redundancy can be utilized for improving the accuracy of the system. This is carried out by giving the links different weights depending on in which path they belong.

[38] Using the example of FIG. 6a, FIG. 8a-8c illustrate the calculation of the center of gravity in the second embodiment. As there are three nodes N1 in this example, three different centers of gravity are obtained. FIG. 8a illustrates the calculation of the center of gravity when the path from node N6 to node N3 is involved, FIG. 8b illustrates the said calculation when the path from node N2 to node N4 is involved, and FIG. 8c illustrates said calculation when the path from node N2 to node N5 is involved. Generally, K centers of gravity are obtained, K being the number of nodes representing the parameter set, and also the number of paths including a node representing the parameter set in question. In the second embodiment the adjusted positions of of the three nodes N1 are then the centers of gravity GP1, GP2, and GP3, as calculated for each of said nodes.

[39] FIG. 9a- 9c illustrate the links of the nodes whose positions are adjusted in FIG. 8a-8c. As can be seen, there are three nodes N1 in the accuracy database, each including six links to the neighboring nodes.

[40] As mentioned above, the links can be weighted differently during the adjusting step. In the examples of FIG. 8a, 8b and 8c, a link belonging to the path in question has a value of one, while the other links have a weight value w1 which is preferably between one and zero. In this way certain paths can be weighted with respect to the others. The weights can be determined statistically. For example, if a certain path is more probable than the others, the link leading

FIG. 2 illustrates the location-dependent information available from a typical cellular network utilizing sectored cells.

FIG. 3 illustrates a system in accordance with one embodiment of the present invention.

FIG. 4 illustrates a first embodiment of the transition network formed in a method of the invention.

FIG. 5 illustrates the initial position of each node in the network of FIG. 4.

FIG. 6a-6d illustrate the adjusting of node positions in the first embodiment of the transition network.

FIG. 7 illustrates a second embodiment of the transition network of the invention.

FIG. 8a-~~8d~~ 8c illustrate the adjusting of node positions in the second embodiment of the transition network.

FIG. 9a-~~9d~~ 9c illustrate the links relating to the nodes whose positions are adjusted in FIG. 8a-~~8d~~ 8c.

FIG. 10 illustrates the general process according to one aspect of the invention.

FIG. 11 is a flow diagram illustrating an example of optimization of the transition network.

Detailed Description of the Invention

[25] As mentioned above, the method of the invention applies to various kinds of location-dependent information. According to the cellular system in question, the location-dependent information provided by the network can be signal strength or signal delay, for example. The determination of the location in current cellular networks is widely based on the Timing Advance value, because the Timing Advance value is directly available from the network. Therefore, Timing Advance is in this context used as an example of the location-dependent signal information available from the mobile network for location determination.

[26] As is known, Timing Advance indicates how far from the base station the mobile most probably is located. FIG. 1 illustrates the location dependent information provided by a network with omni-directional base station antennas, whereas FIG. 2 illustrates the same in connection with sectored cell sites. The network typically provides the Timing Advance information as the minimum and maximum distance from the antenna (R_{min} and R_{max}), in which case with a certain probability the mobile terminal is located between these limits, i.e. the hatched

nodes, each belonging to a different path. Thus, in this case each of the nodes marked by a triangle in FIG. 4 is not stored as a single node, but rather as a node group in which each node belongs to a different path. Using the above example, FIG. 7 illustrates the logical content of the accuracy database in the second embodiment. The database includes separate paths P1...P1000, each comprising several nodes. If two nodes, such as nodes N11 and N21, represent the same parameter set, links (pointers) are created from each of said nodes to the neighboring nodes of all the other nodes representing the same parameter set. Thus, each node can include two types of links, those linking the node to the neighboring nodes in the same path and those linking the node with the neighboring nodes of the other nodes representing the same parameter set as the node itself. Although the database now includes redundancy, this redundancy can be utilized for improving the accuracy of the system. This is carried out by giving the links different weights depending on in which path they belong.

[38] Using the example of FIG. 6a, FIG. 8a-8c illustrate the calculation of the center of gravity in the second embodiment. As there are three nodes N1 in this example, three different centers of gravity are obtained. FIG. 8a illustrates the calculation of the center of gravity when the path from node N6 to node N3 is involved, FIG. 8b illustrates the said calculation when the path from node N2 to node N4 is involved, and FIG. 8c illustrates said calculation when the path from node N2 to node N5 is involved. Generally, K centers of gravity are obtained, K being the number of nodes representing the parameter set, and also the number of paths including a node representing the parameter set in question. In the second embodiment the adjusted positions of of the three nodes N1 are then the centers of gravity GP1, GP2, and GP3, as calculated for each of said nodes.

[39] FIG. 9a-~~9d~~ 9c illustrate the links of the nodes whose positions are adjusted in FIG. 8a-~~8d~~8c. As can be seen, there are three nodes N1 in the accuracy database, each including six links to the neighboring nodes.

[40] As mentioned above, the links can be weighted differently during the adjusting step. In the examples of FIG. 8a, 8b and 8c, a link belonging to the path in question has a value of one, while the other links have a weight value w1 which is preferably between one and zero. In this way certain paths can be weighted with respect to the others. The weights can be determined statistically. For example, if a certain path is more probable than the others, the link leading